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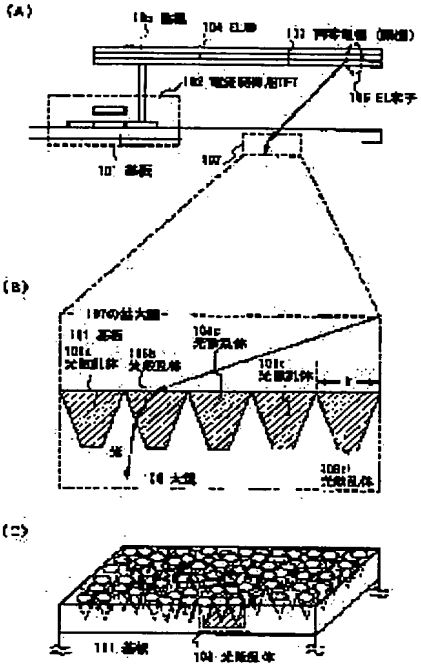
(54) SELF-LUMINOUS DEVICE AND ELECTRIC APPLIANCE USING THE SAME

(57)Abstract:

PROBLEM TO BE SOLVED: To provide a self-luminous device and an electric appliance provided with it capable of enhancing a light taking-out efficiency of a light-emitting device, particularly an EL element.

SOLUTION: A light taking-out efficiency can be enhanced by providing a light scattering body 108 formed by etching a transparent film on a substrate 101. A fine processing of pitch becomes possible by forming the light scattering body 108 by etching the transparent film. The self-luminous device high in luminous efficiency can thus be provided by forming the light scattering body 108.



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CLAIMS

[Claim(s)]
[Claim 1] Spontaneous light equipment characterized by inserting the insulator between a light emitting device and a light-scattering object.
[Claim 2] Spontaneous light equipment which is spontaneous light equipment which has the second electrode formed on EL layer formed on the first electrode electrically connected with TFT formed on an insulator, and said TFT, and said first electrode, and said EL layer, and is characterized by forming a light-scattering object in the opposite side of said first electrode through said insulator.
[Claim 3] It is spontaneous light equipment which said first electrode is an anode plate and is characterized by said second electrode being cathode in claim 2.
[Claim 4] It is spontaneous light equipment characterized by for said first electrode consisting of an ingredient of translucency, and said second electrode consisting of an ingredient of protection-from-light nature in claim 2 or claim 3.
[Claim 5] Spontaneous light equipment which is spontaneous light equipment which has the second electrode formed on EL layer formed on the first electrode formed on an insulator, and said first electrode, and said EL layer, and is characterized by forming a light-scattering object in the opposite side of said first electrode through said insulator.
[Claim 6] It is spontaneous light equipment which said first electrode is an anode plate and is characterized by said second electrode being cathode in claim 5.
[Claim 7] It is spontaneous light equipment characterized by for said first electrode consisting of an ingredient of translucency, and said second electrode consisting of an ingredient of protection-from-light nature in claim 5 or claim 6.
[Claim 8] It is spontaneous light equipment characterized by forming said light-scattering object from the ingredient of translucency in any 1 of claim 1 thru/or claims 7.
[Claim 9] It is spontaneous light equipment characterized by said light-scattering object consisting of a polycarbonate, polyimide, BCB, indium oxide, or tin oxide in any 1 of claim 1 thru/or claims 8.
[Claim 10] It is spontaneous light equipment characterized by being the thickness in which the thickness (H) of said light-scattering object has the relation of H>=W1 to the pitch (W1) of said light-scattering object in any 1 of claim 1 thru/or claims 9.
[Claim 11] Spontaneous light equipment characterized by a pixel pitch being twice [more than] the pitch of said light-scattering object in any 1 of claim 1 thru/or claims 10.
[Claim 12] It is spontaneous light equipment characterized by the angle of said light-scattering object and said insulator to make being 60 degrees or more less than 180 degrees in any 1 of claim 1 thru/or claims 11.
[Claim 13] The electric appliance characterized by using spontaneous light equipment according to claim 1 to 12.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] In case this invention passes a current for EL (electro luminescence) component and takes out field-like luminescence, it relates to the component structure which raises the ejection effectiveness of the light which emitted light inside the component. In addition, the spontaneous light equipment of this invention shall contain the organic electroluminescence display (OELD:Organic EL Display) or the organic light emitting diode (OLED:Organic Light Emitting Diode) which used the organic light emitting device (light emitting device) as a spontaneous light type component.
[0002]
[Description of the Prior Art] Although the light which carried out outgoing radiation from spontaneous light equipment is taken out as field-like luminescence in atmospheric air, since the configuration of spontaneous light equipment and the substrate located in an atmospheric interface is monotonous, there is much light which cannot be taken out from the inside of a substrate, and the ejection effectiveness has become 20 - 50%.
[0003]
[Problem(s) to be Solved by the Invention] This invention is made in order to solve the above-mentioned technical problem, and it makes it a technical problem to raise the ejection effectiveness of the light produced in a light emitting device, especially an EL element by forming a toothing-like light-scattering object in the field of the opposite side of a substrate. Furthermore, the transparent film on a substrate is etched and formed as a light-scattering object, and micro processing of a pitch is made possible. And let it be a technical problem to offer spontaneous light equipment with more high luminous efficiency by forming a light-scattering object with a detailed pitch.
[0004]
[Means for Solving the Problem] In this invention, the configuration used in order to raise the ejection effectiveness of light is explained using drawing 1 .
[0005] Drawing 1 (A) shows the example at the time of using this invention to the spontaneous light equipment of a active-matrix mold. 101 is a substrate which consists of an insulator and TFT102 for current control is formed on the substrate 101. The drain field of TFT102 for current control is electrically connected to the pixel electrode 103. (Connecting with a source field is also possible.) In addition, the pixel electrode 103 is an anode plate, and in order to carry out outgoing radiation of the light from the pixel electrode 103 side of EL element 106, the pixel electrode 103 is formed by the transparency electric conduction film here.
[0006] Furthermore, the EL layer 104 is formed on the pixel electrode 103, and cathode 105 is formed on the EL layer 104. EL element 106 which consists of the pixel electrode 103, an EL layer 104, and cathode 105 by this is formed.
[0007] Irregularity is made to form in the near field in which the rear face of a substrate 101, i.e., TFT, is not formed in the spontaneous light equipment which has the above configurations. In addition, 107 shows some light-scattering objects 108, and the enlarged drawing of further 107 is shown.
[0008] Since it can prevent light's carrying out total reflection and being shut up by the light-scattering object, since the incident angle from the light-scattering object 108 to the inside of atmospheric air 109 can be prevented from exceeding a critical angle by forming the light-scattering object 108, the ejection effectiveness of the light from EL element 106 can be raised. In addition, a light-scattering object is formed by etching the transparent film which becomes by the transparent material. In addition, the transparent film as used in the field of in this specification means the transparent film to the light.

[0009] After the light which passed through the inside of a substrate 101 passes the light-scattering object 108, signs that outgoing radiation is carried out are shown in the enlarged drawing of 107 shown in drawing 1 (B) into atmospheric air. Moreover, the light-scattering objects 108a, 108b, 108c, 108d, and 108e shown by drawing 1 (B) are formed in the shape of a dot, respectively, and call these the light-scattering object 108 in this specification. In addition, the perspective view of the field in which the light-scattering object 108 is formed is shown in drawing 1 (C).
[0010] In this invention, after carrying out incidence of the light which carried out outgoing radiation from EL element 106 into a substrate 101, incidence of it is carried out to the light-scattering object 108.
[0011] In addition, optical refraction is decided by the include angle (incident angle) and the refractive index of a medium of incident light, as shown in drawing 2 . Furthermore, this relation follows the following formulas (Snell's law). That is, when the light (incident light) the refractive index carried out [light] incidence at an angle of theta 1 in the medium 1 (201) which is n1 carries out incidence to the medium 2 (202) whose refractive index is n2, they are the following formulas [0012].
[Formula 1]

$$n_1 \sin\theta_1 = n_2 \sin\theta_2$$

[0013] ******** -- it becomes the light (refracted light) of the include angle [like] theta 2. In addition, the incident angle theta 1 from which the include angle theta 2 of the refracted light becomes 90 degrees is called critical angle. Moreover, when the incident angle theta 1 over a medium 2 becomes larger than a critical angle, total reflection of the light is carried out. That is, light will be shut up by the medium 1.
[0014] Furthermore, the formula (Fresnel's principle) showing the reflection factor (R) and permeability (T) of energy below is realized.
[0015]
[Formula 2]

$$R = \frac{1}{2}\left\{\frac{\sin^2(\theta_1-\theta_2)}{\sin^2(\theta_1+\theta_2)} + \frac{\tan^2(\theta_1-\theta_2)}{\tan^2(\theta_1+\theta_2)}\right\}$$

[0016]
[Formula 3] T=1-R [0017] That is, since a reflective component will arise if the refractive indexes of a substrate 101 and the light-scattering object 108 differ, it turns out that the refractive index of a substrate 101 and the light-scattering object 108 is good in it being the same.
[0018] A reflection factor becomes large, as shown in drawing 1 from these formulas 1-3 when a refractive index carries out outgoing radiation of the light from the light-scattering object 108 of refractive indexes 1.45-1.60 into the atmospheric air 109 which is 1, namely, when carrying out outgoing radiation of the light to a medium with a small refractive index from a medium with a large refractive index. Moreover, if an incident angle becomes larger than a critical angle, total reflection of the light will be carried out. That is, what is necessary is just to make the configuration of the light-scattering object 108 into a configuration to which an incident angle becomes small.
[0019] More light was scattered about, and it is easy to take out and was made make the configuration of a light-scattering object concave convex, make it the incident angle to the inside of atmospheric air become small, and to consist of the above thing into atmospheric air by this invention.
[0020] In addition, in this invention, since the irregular irregularity formed of etching serves as the light-scattering object 108, it is not necessary to unify a configuration into a precision, and there is an advantage that production is easy.
[0021] Although it can be used for many spontaneous light equipments, since this invention can attain low-power-izing and reinforcement of an EL element, it is very effective in the EL element using EL ingredient especially influenced notably of the use effectiveness of light.
[Embodiment of the Invention] About the gestalt of operation of this invention, detailed explanation will be given in the example shown below.
[0022] [Example 1] This example shows the example which used this invention to the spontaneous light equipment of the active-matrix mold which penetrates light to a pixel electrode side. First, as shown in drawing 3 , the transparent film is formed on the rear face of a substrate 301. The compound film which combined the film or these which consist of a polycarbonate, acrylic resin, polyimide, a polyamide, organic resin called BCB (benz-cyclo-butene) and indium oxide, tin oxide, or a zinc oxide as a transparent material which forms the transparent film is used.
[0023] Next, the light-scattering object 302 as shown by drawing 3 (A) is made to form by etching this

transparent film. The light-scattering object 302 formed at this time is explained using drawing 4 (A). In addition, the light-scattering object 302 formed in trapezoidal shape is shown in drawing 4 (A). Moreover, since the notation same with using by drawing 3 is used for the notation used here, it is good to make it correspond each time.

[0024] The light-scattering object 302 with which drawing 4 (A) was formed in the rear face of a substrate by drawing 3 (A) shows the structure to which drawing 3 (A) made the upper and lower sides reverse so that it may come to the bottom of a substrate. And the light which emitted light by the EL element which sees from a substrate 301 and is in the TFT side presupposes that outgoing radiation is carried out to the light-scattering object 302 by the incident angle theta 1 as shown in drawing 4 (A). Here, if the relation it is unrelated n1>n2 is realized [refractive index] in the refractive index of n1 and the light-scattering object 302 when the refractive index of a substrate 301 is set to n2, incidence of the light will be carried out at the include angle which becomes the light-scattering object 302 theta2.

[0025] on the other hand -- n1 -- < -- n2 -- if relation is realized -- light -- the light-scattering object 302 -- theta2' -- outgoing radiation is carried out at an include angle. that is, theta2>theta2' -- relation is realized and the outgoing radiation angle of the light by which outgoing radiation is carried out from the small place of a refractive index at the large place of a refractive index becomes small.

[0026] However, since the outgoing radiation angle becomes large since outgoing radiation will be carried out to a medium small from a medium with a light large [of a refractive index] when taking out in the atmospheric air from the light-scattering object 302 here, and it becomes large [a reflection factor] again, it is hard coming to carry out outgoing radiation. Then, the angles theta3 and theta4 with the substrate whose light-scattering object 302a is an insulator as shown in drawing 4 (A) to make are restricted. In this invention, as a configuration from which the ejection effectiveness of the light by which outgoing radiation is carried out in the direction of a normal of a substrate with the highest ejection effectiveness does not fall, the include angle of theta3 and theta4 is formed so that it may become 60 degrees or more. However, theta3 and theta4 do not necessarily need to be formed at the same include angle.

[0027] Moreover, in order to make it an image not fade, it is made, as for the pitch of light-scattering object 302a, for the die length W1 of a contact part with a substrate to become 1/2 or less [of a pixel pitch]. Moreover, it is better as the die length W2 of the raised bottom section of trapezoidal shape is shortened, in order to make light easier to take out. In addition, being set to W2=0 is most desirable.

[0028] Furthermore, in order to form the include angle of theta3 and theta4 of the light-scattering object 302 so that it may become 60 degrees or more, as for the thickness H of the transparent film, it is desirable to make it the relation it is unrelated H>=W1 to the pitch (W1) of the light-scattering object a302.

[0029] Moreover, it is not necessary to form an exact configuration or to graduate a front face using metal mold etc., and detailed irregularity should just be formed in the side which carries out outgoing radiation of the light of the rear face of a substrate in this invention.

[0030] The light-scattering object 302 is formed in the rear face of a substrate 301 as mentioned above. Moreover, the pattern which can be formed as a light-scattering object 302 is shown in drawing 4 (B) - (G). Drawing 4 (B) is the example which opened and prepared spacing between square light-scattering objects in the rear face of a substrate. drawing 4 (C) -- a light-scattering object -- a substrate -- perfect -- covering -- **** -- in addition -- and it is the example established without opening spacing between light-scattering objects. Moreover, drawing 4 (D) is an example in the case of making an inverse tapered shape-like light-scattering object form in the rear face of a substrate, and drawing 4 (E) is making the semi-sphere-like light-scattering object form in the rear face of a substrate. Furthermore, an ellipse-like light-scattering object is shown in drawing 4 (F), and the example which it saw [example] to drawing 4 (G) from the cross section, and made the triangle-like light-scattering object form in it is shown in it.

[0031] In addition, the light-scattering object shown in drawing 4 may open and prepare spacing between the light-scattering object, and it may prepare it so that each of a light-scattering object may lap.

[0032] After making the light-scattering object 302 form in the rear face of a substrate 301, the p channel mold 303 and TFT 304 is formed by the well-known approach on the substrate 301 which formed the insulator layer on the front face. In addition, TFT structure is not limited although the planar mold TFT is mentioned as the example in this example. That is, the reverse stagger mold TFT may be used.

[0033] Next, the pixel electrodes 305 and 306 electrically connected to each of the p channel mold 303 and TFT 304 are formed. In order to function as an anode plate of an EL element as pixel electrodes 305 and 306, the large ingredient of a work function is used. Therefore, in this example, the oxide electric conduction film (compound film which combined the film or these which consist of indium oxide, tin oxide, or a zinc oxide) is used as an ingredient (or transparent material) of transparent translucency to the light. A

gallium may be added on this oxide electric conduction film (drawing 3 (B)).
[0034] Next, banks 307 and 308 are formed by the resin film so that the edge of the pixel electrodes 305 and 306 may be surrounded, and the EL layer 309 is formed on it. In this example, banks 307 and 308 are formed by the acrylic film, and the EL layer 309 is formed with a spin coat method. As an ingredient of the EL layer 309, the poly fluorene which is a macromolecule organic material is used. Of course, a fluorescent material may be added to the poly fluorene and chromaticity control may be performed (drawing 3 (C)).
[0035] Next, cathode is formed using the ingredient of protection-from-light nature. In addition, in this example, vapor codeposition of aluminum and the lithium is carried out as cathode 311, the alloy film is formed in the thickness of 300nm, and a silicon nitride film is further formed by the spatter as passivation film 312 on it. It is also effective in this a carbon film and to specifically carry out the laminating of the DLC (diamond-like carbon) film.
[0036] The spontaneous light equipment of the structure shown in drawing 3 (D) as mentioned above is completed. What is necessary is for resin to enclose an EL element or just to enclose an EL element with a closed space so that an EL element cannot touch the open air after this.
[0037] [Example 2] This example shows the example which used this invention to the spontaneous light equipment of the active-matrix mold which reflects light by the pixel electrode side. First, the n channel mold 502 and TFT 503 is formed by the well-known approach on the substrate 501 which formed the insulator layer on the front face as shown in drawing 5 . In addition, TFT structure is not limited although the planar mold TFT is mentioned as the example in this example. That is, the reverse stagger mold TFT may be used.
[0038] At this time, drain wiring is used as pixel electrodes 504 and 505 in each of the n channel mold 502 and TFT 503. Since it is necessary to reflect luminescence with the pixel electrodes 504 and 505 in the case of this example, a reflexible high metal membrane is used as pixel electrodes 504 and 505. Moreover, in order to function on coincidence also as cathode of an EL element, the metal membrane containing the small ingredient of a work function is used. The alloy film containing aluminum and a lithium is used in this example (drawing 5 (A)).
[0039] Next, banks 506 and 507 are formed by the resin film so that the edge of the pixel electrodes 504 and 505 may be surrounded, and the EL layer 508 is formed on it. In this example, banks 506 and 507 are formed by the acrylic film, and the EL layer 508 is formed with vacuum deposition. as an ingredient of the EL layer 508, it is a low-molecular organic material -- it uses Alq3 (tris-8-quinolinolato aluminum complex). Of course, a fluorescent material may be added to Alq3 and chromaticity control may be performed to it (drawing 5 (B)).
[0040] Next, it forms in the thickness of 300nm of oxide electric conduction film which added the oxidation gallium to the zinc oxide as an anode plate 510, and a silicon nitride film is further formed by the spatter as passivation film 511 on it. It is also effective in this a carbon film and to specifically carry out the laminating of the DLC (diamond-like carbon) film (drawing 5 (C)).
[0041] Next, the closure film which consists of organic resin as shown in drawing 5 (D) is made to form. At this time, the closure film is formed so that an EL element cannot touch the open air.
[0042] Furthermore, the closure substrate 513 is formed on the closure film 512. At this time, by formation of the closure film, and a series of processings, the closure substrate 513 is formed so that an EL element may not touch on the open air.
[0043] Next, the transparent film is made to form on a closure substrate. The compound film which combined the film or these which consist of a polycarbonate, acrylic resin, polyimide, a polyamide, organic resin called BCB (benz-cyclo-butene) and indium oxide, tin oxide, or a zinc oxide as a transparent material which forms the transparent film is used. Moreover, as for the thickness (H) of the film transparent in order to form the include angle of theta3 and theta4 of the light-scattering object 514 so that it may become 60 degrees or more, it is desirable to make it the relation it is unrelated H>=W1 to the pitch (W1) of a light-scattering object. The light-scattering object 514 as shown by drawing 5 (E) is made to form by etching this transparent film.
[0044] Moreover, it is not necessary to necessarily prepare the closure film formed by the organic resin film as shown by this example, and you may make it enclose an EL element with a closed space. In addition, since it is hard coming to take it out when carrying out outgoing radiation of the light to a medium with a low refractive index from a medium with a high refractive index, it is good to establish the light-scattering object 514 on the interface 511 of the passivation film 511 and a closed space, i.e., the passivation film, in this case.
[0045] In this way, since the light-scattering object is prepared in the field as for which light finally carries

out outgoing radiation compared with the usual closure structure, the obtained spontaneous light equipment can acquire optical high ejection effectiveness compared with conventional spontaneous light equipment. Since the electrical potential difference for making an EL element drive can be made low by this, high life-ization of an EL element can be attained.

[0046] In addition, it combines with any configuration of an example 1, and the configuration of this example can be carried out.

[0047] [Example 3] Although the example 1 and the example 2 showed the example which used this invention for TFT of a planar mold, this example shows the structure which used this invention for TFT of a reverse stagger mold to drawing 6 . In drawing 6 , (A) shows the structure of the spontaneous light equipment of the active-matrix mold which penetrates light to a pixel electrode side, and (B) shows the structure of the spontaneous light equipment of the active-matrix mold which reflects light by the pixel electrode side.

[0048] In drawing 6 , it is the p channel mold TFT with which 601 is used with a substrate and 602 is used by drawing 6 (A), and 603 is the n channel mold TFT used by drawing 6 (B). Each of these is the structures where the gate electrode is formed on the substrate 601 and the source field, the drain field, and the channel formation field are formed through gate dielectric film on the gate electrode. Moreover, 605 is a pixel electrode and the bank into which 605 divides pixel inter-electrode is formed. The EL layer 606 is formed on the pixel electrode 605, and cathode 607 and the passivation film 608 are formed on the EL layer 606.

[0049] In addition, since drawing 6 (A) is structure which penetrates light to a pixel electrode side, the light-scattering object 609 is formed in the rear face of a substrate 601. Moreover, since drawing 6 (B) is the structure of reflecting light by the pixel electrode side, a light-scattering object is formed on the closure structure which consists of the closure film 610 and the closure substrate 611 on the passivation film 608.

[0050] In addition, since creation is easy compared with TFT of a planar mold, the TFT structure of a reverse stagger mold can reduce the number of masks. Furthermore, since it is possible to form gate dielectric film and a channel formation field continuously, there is an advantage that it can form without polluting the interface.

[0051] In addition, it combines with any configuration of an example 1 and an example 2 freely, and the configuration of this example can be carried out.

[0052] [Example 4] This example shows the example which used this invention to the spontaneous light equipment of the passive matrix mold which emits light through a substrate.

[0053] First, the transparent film is made to form on the rear face of a substrate 701. The compound film which combined the film or these which consist of a polycarbonate, acrylic resin, polyimide, a polyamide, organic resin called BCB (benz-cyclo-butene) and indium oxide, tin oxide, or a zinc oxide as a transparent material which forms the transparent film is used. Moreover, as for the thickness (H) of the film transparent in order to form the include angle of theta3 and theta4 of a light-scattering object so that it may become 60 degrees or more, it is desirable to make it the relation it is unrelated H>=W1 to the pitch (W1) of a light-scattering object.

[0054] The light-scattering object 702 of trapezoidal shape as shown in drawing 7 (A) is made to form by etching this transparent film. In the case of etching, the transparent film is etched superfluously, and it is necessary to make it not exposed [a substrate 701] to a front face. This is because optical refraction with the light-scattering object 702 is no longer made fully, when a substrate is exposed to a front face.

[0055] Next, that which made vertical reverse the substrate 701 shown by drawing 7 (A), and turned the front face of a substrate 701 up is shown in drawing 7 (B). And after forming an insulator layer on substrate 701 front face, an anode plate 703 is formed on an insulator layer. In this example, the oxide electric conduction film which consists of a compound of indium oxide and the tin oxide as an anode plate 703 is used (drawing 7 (B)).

[0056] This anode plate 703 was formed in the direction parallel to space band-like, and is located in a line in the direction where it is perpendicular to space in the shape of a stripe. This structure is the same as that of well-known passive matrix mold spontaneous light equipment.

[0057] Next, a septum 704 is formed so that it may intersect perpendicularly with an anode plate 703. A septum 704 is formed in order to separate the metal membrane used as cathode. In this example, using the two-layer resin film, it is processed so that it may become a T character mold. Such structure can be acquired if a lower layer etching rate etches on quick conditions compared with the upper layer.

[0058] Next, the EL layer 705 is formed. In this example, the EL layer 705 is formed with vacuum deposition. as an ingredient of the EL layer 705, it is a low-molecular organic material -- it uses Alq3 (tris-8-quinolinolato aluminum complex). Of course, a fluorescent material may be added to Alq3 and chromaticity

control may be performed to it.
[0059] Next, the alloy film which carried out vapor codeposition of aluminum and the lithium as cathode 707 is formed in the thickness of 300nm. At this time, it dissociates along with a septum 704, and cathode 707 is formed in band-like toward the space back, and is formed together with the shape of a stripe. Furthermore, the resin film is formed by the ink jet method or print processes as passivation film 708 on it. It is also effective in this a carbon film and to specifically carry out the laminating of the DLC (diamond-like carbon) film.
[0060] The spontaneous light equipment of the structure shown in drawing 7 (C) as mentioned above is completed. What is necessary is for resin just to enclose an EL element so that an EL element cannot touch the open air after this.
[0061] In this way, since the light-scattering object is prepared in the outgoing radiation side of light compared with the usual closure structure, as for the obtained spontaneous light equipment, optical high ejection effectiveness is acquired compared with conventional spontaneous light equipment. Since the electrical potential difference for making an EL element drive can be made lower than usual by this, high life-ization of an EL element can be attained.
[0062] In addition, it combines with any configuration of an example 1 - an example 3, and the configuration of this example can be carried out.
[0063] [Example 5] This example shows the example which used this invention to the spontaneous light equipment of the passive matrix mold which emits light towards the upper part of a substrate. First, cathode 802 is formed on the substrate 801 which formed the insulator layer on the front face. In this example, the electrode of the structure which carried out the laminating of the MgAg film (metal membrane which carried out vapor codeposition of magnesium and the silver) to the aluminum film as cathode 802 is used.
(Drawing 8 (A))
[0064] This cathode 802 was formed in the direction parallel to space band-like, and is located in a line in the direction where it is perpendicular to space in the shape of a stripe.
[0065] Next, a septum 803 is formed so that it may intersect perpendicularly with cathode 802. A septum 803 is formed in order to separate the oxide electric conduction film used as an anode plate. In this example, using the two-layer resin film, it is processed so that it may become a T character mold. Such structure can be acquired if a lower layer etching rate etches on quick conditions compared with the upper layer.
[0066] Next, the EL layer 804 is formed. In this example, the EL layer 804 is formed with vacuum deposition. as an ingredient of the EL layer 804, it is a low-molecular organic material -- it uses Alq3 (aluminum kino RIRATO complex). Of course, a fluorescent material may be added to Alq3 and chromaticity control may be performed to it.
[0067] Next, the oxide electric conduction film which consists of a compound of indium oxide and a zinc oxide as an anode plate 806 is formed in the thickness of 300nm. At this time, it dissociates along with a septum 803, and an anode plate 806 is formed in band-like toward the space back, and is formed together with the shape of a stripe. Furthermore, the resin film is formed by the ink jet method or print processes as passivation film 807 on it. It is also effective in this a carbon film and to specifically carry out the laminating of the DLC (diamond-like carbon) film.
[0068] If the structure shown in drawing 8 (B) as mentioned above is formed, the closure film 808 will be formed by enclosing an EL element by resin so that an EL element cannot touch the open air. Furthermore, the closure substrate 809 is formed on the closure film 808.
[0069] Next, the transparent film is made to form on the closure substrate 809. The compound film which combined the film or these which consist of a polycarbonate, acrylic resin, polyimide, a polyamide, organic resin called BCB (benz-cyclo-butene) and indium oxide, tin oxide, or a zinc oxide as an ingredient which forms the transparent film is used. Moreover, as for the thickness (H) of the film transparent in order to form the include angle of theta3 and theta4 of a light-scattering object so that it may become 60 degrees or more, it is desirable to make it the relation it is unrelated H>=W1 to the pitch (W1) of a light-scattering object. The light-scattering object 810 which shows this transparent film to drawing 8 (C) by etching is formed.
[0070] As mentioned above, it becomes possible to take out more efficiently the light generated from the EL element by forming the light-scattering object 810 of detailed structure in the field as for which light carries out outgoing radiation.
[0071] Moreover, it is not necessary to necessarily prepare the closure film formed by the organic resin film as shown by this example, and you may make it enclose an EL element with a closed space. In addition, since it is hard coming to take it out when carrying out outgoing radiation of the light to a medium with a low refractive index from a medium with a high refractive index, in this case, it establishes a light-scattering

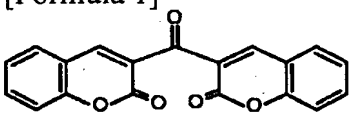
object on the interface 807 of the passivation film 807 and a closed space, i.e., the passivation film, and forms the closure substrate 809 on a closed space.
[0072] In this way, since the obtained spontaneous light equipment has prepared the light-scattering object in the field as for which light finally carries out outgoing radiation compared with the usual closure structure, it can raise the ejection effectiveness of light compared with conventional spontaneous light equipment. Since the electrical potential difference for making an EL element drive can be made lower than usual by this, high life-ization of an EL element can be attained.
[0073] In addition, it combines with any configuration of an example 1 - an example 4, and the configuration of this example can be carried out.
[0074] [Example 6] Next, the example which used this invention for the front light is shown. Drawing 9 is drawing showing the configuration of a front light. Drawing 9 (A) and drawing 9 (B) are the sectional views of a front light, and drawing 9 (C) is the rear-face perspective view of a light guide plate 901.
[0075] As shown in drawing 9 (A), the light source 902 is arranged at side-face 901a of a light guide plate 901, and the reflector 903 is formed behind the light source 902. Moreover, the light-scattering object 904 is established in contact with the inferior surface of tongue of a light guide plate 901.
[0076] The light guide plate 901 consists of a rectangular parallelepiped-like transparent material and is monotonous, and a shorter side is a very short rectangle compared with a long side among four side faces. The permeability (total light transmission) to the light is 85% or more preferably 80%, and the ingredient of a light guide plate 901 is because the light whose incident angle of a light guide plate 901 is 90 degrees can be made refracted by side-face 901a and it can lead to the light guide plate 901 interior, so that a refractive index is larger than 21/2. In this example, the refractive index uses the ingredient which is the range of 1.4-1.7.
[0077] Ingredients, such as a quartz, glass, and a plastic, can be used as such a transparent material. As a plastic, it is a simple substance, or ingredients, such as methacrylic resin, a polycarbonate, polyarylate, an AS resin (AKURIRO tolyl, styrene polymer), and MS resin (methyl methacrylate, styrene polymer), can be mixed and used.
[0078] Moreover, a cold cathode tube and LED are used for the light source 902, and it is arranged along with side-face 901a of a light guide plate 901. Moreover, along with side-face 902b, the two light sources may be established face to face.
[0079] Next, the light-scattering object 904 is etched and formed after forming the transparent film on a light guide plate 901. The compound film which combined the film or these which consist of a polycarbonate, acrylic resin, polyimide, a polyamide, organic resin called BCB (benz-cyclo-butene) and indium oxide, tin oxide, or a zinc oxide as a transparent material which forms the transparent film is used. Moreover, as for membranous thickness (H), it is desirable to make it the relation it is unrelated H>=W1 to the pitch (W1) of a light-scattering object.
[0080] The liquid crystal display from which the ejection of light becomes efficient can be obtained by preparing the front light formed as mentioned above between a liquid crystal panel (LCD) 905 and a user.
[0081] In this example, since light is reflected on the side face of a light-scattering object and he is trying to irradiate a liquid crystal panel, the incident angle to a liquid crystal panel can be made small. Since the component of the light which, as a result, illuminates the pixel electrode of a liquid crystal panel perpendicularly becomes large, light can be used efficiently.
[0082] In addition, although the sectional view of the trapezoidal shape acquired when the light-scattering object 904 is cut in the direction of x-x' was shown in drawing 9 (C), when the acute angle in the light-scattering object 904 of trapezoidal shape is set to theta5 and theta6, the larger one is desirable [these include angles]. Light which carries out outgoing radiation can be made easy to collect in the direction of a liquid crystal panel from a front light, if theta5 and theta6 are enlarged. In addition, it is not necessary to make theta5 and theta6 into the same include angle, and they may differ.
[0083] Moreover, in this example, although this was etched and the light-scattering object 904 was formed after newly forming the transparent film on a light guide plate 901, the light guide plate 1101 which has structure as etched light guide plate 901 front face (liquid crystal panel side) directly and shown in drawing 11 (A) may be formed.
[0084] [Example 7] Next, the example which used this invention for the back light is shown. Drawing 10 is drawing showing the configuration of a back light. Drawing 10 (A) is the sectional view of a back light, and drawing 10 (B) is the perspective view of a back light.
[0085] As shown in drawing 10 (A), the light source 1002 is arranged at side-face 1001a of a light guide plate 1001, and the reflector 1003 is formed behind the light source 1002. Moreover, the light-scattering

object 1004 is established in contact with the top face of a light guide plate 1001.
[0086] Therefore, the light which carried out outgoing radiation by the light source 1002 irradiates a liquid crystal panel (LCD) 1005, after passing the light-scattering object 1004 from a light guide plate 1001.
[0087] Moreover, a cold cathode tube and LED are used like the case of a front light, and the light source 1002 is arranged along with side-face 1001a of a light guide plate 1001. Moreover, along with side-face 1002b, the two light sources may be established face to face.
[0088] Moreover, in this example, although this was etched and the light-scattering object 1004 was formed after making the transparent film newly form on a light guide plate 1001, the light guide plate 1102 which has structure as etched light guide plate 1001 the very thing directly and shown in drawing 11 (B) may be formed.
[0089] [Example 8] By this example, when carrying out the spontaneous light equipment of this invention by digital drive, it explains whether TFT for current control is made to drive in the field which has what kind of the volt ampere characteristic.
[0090] The current on which it will flow an EL element to it if the electrical potential difference to which an EL element is impressed changes changes a lot exponentially. If another view is carried out, even if the magnitude of the current which flows an EL element changes, the electrical-potential-difference value impressed to an EL element will seldom change. And the brightness of an EL element is mostly in direct proportion to the current which flows to an EL element, and becomes large. Therefore, by controlling the magnitude (electrical-potential-difference value) of the electrical potential difference impressed to an EL element, the direction which controls the brightness of an EL element by controlling the magnitude (current value) of the current which flows an EL element is not influenced by the property of TFT rather than controlling the brightness of an EL element, but control of the brightness of **** and an EL element is easy.

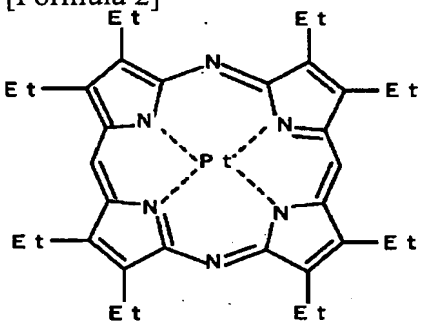
[0091] Drawing 12 is referred to. Drawing 12 (A) illustrates only the component of TFT108 for current control, and EL element 110 in the pixel of the EL display of this invention shown in drawing 1 (A). The volt ampere characteristic of TFT108 for current control shown by drawing 12 (A) and EL element 110 is shown in drawing 12 (B). In addition, the graph of the volt ampere characteristic of TFT108 for current control shown by drawing 12 shows the magnitude of the current which flows to the drain of TFT108 for current control to VDS which is an electrical potential difference between a source field and a drain field, and shows two or more graphs with which the values of VGS which is an electrical potential difference between the source field of TFT108 for current control and a gate electrode differ to drawing 12 .
[0092] As shown in drawing 12 (A), the electrical potential difference built between the counterelectrodes 111 of the terminal 2601 by which the electrical potential difference built between the pixel electrodes and counterelectrodes 111 of EL element 110 is connected to VEL and a current supply line, and EL element 110 is set to VT. In addition, as for VT, the value is fixed by the potential of a current supply line. Moreover, the electrical potential difference between the wiring 2602 to which the electrical potential difference between the source field and drain field of TFT108 for current control is connected to the gate electrode of VDS and TFT108 for current control, and a source field, i.e., the electrical potential difference between the gate electrode of TFT108 for current control and a source field, is set to VGS.
[0093] The n channel mold TFT, the p channel mold TFT, or whichever is sufficient as TFT108 for current control.
[0094] Moreover, TFT108 for current control and EL element 110 are connected to the serial. Therefore, the current value which flows both components (TFT108 for current control and EL element 110) is the same. Therefore, TFT108 for current control shown in drawing 12 (A) and EL element 110 are driven on the intersection (operating point) of the graph which shows the volt ampere characteristic of both components. In drawing 12 (B), VEL becomes an electrical potential difference between the potential of a counterelectrode 111, and the potential in the operating point. VDS becomes an electrical potential difference between the potential in the terminal 2601 of TFT108 for current control, and the potential in the operating point. That is, VT is equal to the sum of VEL and VDS.
[0095] Here, the case where VGS is changed is considered. The current value which flows to TFT108 for current control becomes large as |VGS| will become large, if it puts in another way as |VGS-VTH| of TFT108 for current control becomes large so that drawing 12 (B) may show. In addition, VTH is the threshold electrical potential difference of TFT108 for current control. Therefore, if |VGS| becomes large so that drawing 12 (B) may show, naturally the current value which flows EL element 110 in the operating point will also become large. The brightness of EL element 110 becomes high in proportion to the current value which flows EL element 110.

[0096] | If the current value which flows EL element 110 when VGS| becomes large becomes large, according to a current value, the value of VEL will also become large. And since the magnitude of VT has become settled with the potential of a current supply line, if VEL becomes large, the part VDS will become small.
[0097] Moreover, as shown in drawing 12 (B), the volt ampere characteristic of TFT for current control is divided into two fields by the value of VGS and VDS. | The field whose fields which are VGS-VTH|<|VDS| are a saturation region and |VGS-VTH|>|VDS| is a linearity field.
[0098] The following formulas 4 are realized in a saturation region. In addition, IDS is a current value which flows the channel formation field of TFT108 for current control. Moreover, it is beta=mu C0 W/L and mu is [the gate capacitance per unit area and W/L of the mobility of TFT108 for current control and C0] the ratios of channel width W of a channel formation field, and channel length L.
[0099]
[Formula 4] IDS=beta 2/2 (VGS-VTH) [0100] Moreover, the following formulas 5 are realized in a linearity field.
[0101]
[Formula 5] IDS=beta {(VGS-VTH) VDS-VDS 2/2}
[0102] As shown in a formula 4, in a saturation region, a current value hardly changes with VDS, but a current value becomes settled only by VGS.
[0103] On the other hand, as shown in a formula 5, as for a linearity field, a current value becomes settled by VDS and VGS. | If VGS| is enlarged, TFT108 for current control will come to operate in a linearity field. And VEL also becomes large gradually. Therefore, only in the part to which VEL became large, VDS becomes small. In a linearity field, if VDS becomes small, the amount of currents will also become small. Therefore, even if it enlarges |VGS|, a current value stops being able to increase easily. | It is set to current value =IMAX when it becomes VGS|=infinity. That is, however it may enlarge |VGS|, the current more than IMAX does not flow. Here, IMAX is a current value which flows EL element 110 at the time of VEL=VT.
[0104] Thus, by controlling the magnitude of |VGS|, the operating point can be made into a saturation region, or can be made into a linearity field.
[0105] By the way, although the same thing of the property of all TFT(s) for current control is ideally [all] desirable, the threshold VTH differs from mobility mu by each TFT for current control in fact in many cases. And if each threshold VTH and mobility mu of TFT for current control differ from each other mutually, as shown in a formula 4 and a formula 5, the current values with the same value of VGS which flow the channel formation field of TFT108 for current control but will differ.
[0106] The current potential property of TFT for current control that a threshold VTH and mobility mu shifted to drawing 13 is shown. A continuous line 2701 is the graph of the current potential property of an ideal, and 2702 and 2703 are the current potential properties of TFT for current control in the case of having differed from the value which a threshold VTH and mobility mu make an ideal, respectively. In a saturation region, the graphs 2702 and 2703 of a current potential property have shifted from the graph 2701 of the current potential property that only the same current value deltaI1 has the property of an ideal, the operating point 2705 of the graph 2702 of a current potential property is in a saturation region, and the operating point 2706 of the graph 2703 of a current potential property presupposes that it was it in the linearity field. In that case, when a gap of the current value in the operating point 2704 of the graph 2701 of the current potential property of having the property of an ideal, and the current value in the operating point 2705 and the operating point 2706 is set to delta I2 and delta I3, respectively, the operating point 2706 in a linearity field is smaller than the operating point 2705 in a saturation region.
[0107] Therefore, when using the drive approach of the digital method shown by the invention in this application, the gradation display which suppressed the brightness unevenness of the EL element by gap of the property of TFT for current control can be performed by making TFT for current control, and an EL element drive so that the operating point may exist in a linearity field.
[0108] Make it moreover, more desirable to drive TFT for current control, and an EL element so that the operating point may exist in the saturation region which can control a current value only by |VGS| in the conventional analog drive.
[0109] As a conclusion of the above movement analysis, the graph of the current value over gate voltage |VGS| of TFT for current control is shown in drawing 14 . | If VGS| is enlarged and it becomes large rather than absolute value |Vth| of the threshold electrical potential difference of TFT for current control, TFT for current control will be in switch-on, and a current will begin to flow. On these specifications, |VGS| at this time will be called lighting starting potential. And if |VGS| is enlarged further, it will become the value

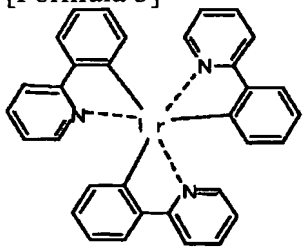
(here, temporarily referred to as A) with which |VGS| fills |VGS-Vth|=|VDS|, and will become a linearity field from a saturation region. If |VGS| is furthermore enlarged, a current value will become large and ** and a current value will be saturated at last. It becomes |VGS|=infinity then.
[0110] In the field of |VGS|<=|Vth|, a current hardly flows as drawing 14 shows. | The field of Vth|<=|VGS|<=A is a saturation region and a current value changes with |VGS|. And the field of A<=|VGS| is a linearity field, the current value which flows to an EL element |VGS| Reaches, is |VDS| Depended, and a current value changes.
[0111] When carrying out the spontaneous light equipment of this invention by digital drive, it is desirable to use the field of |VGS|<=|Vth| and the linearity field of A<=|VGS|. In addition, this example can be freely combined in the spontaneous light equipment shown in an example 1 - an example 3.
[0112] [Example 9] In the spontaneous light equipment of this invention, external luminescence quantum efficiency can be raised by leaps and bounds by using EL ingredient which can use the phosphorescence from a triplet exciton for luminescence. Thereby, low-power-izing of an EL element, reinforcement, and lightweight-ization are attained. Here, a triplet exciton is used and the report which raised external luminescence quantum efficiency is shown. (T. Tsutsui, C.Adachi, S.Saito, Photochemical Processes in Organized Molecular Systems, ed.KHonda (Elsevier Sci.Pub., Tokyo, 1991), p.437.) The molecular formula of EL ingredient (coumarin coloring matter) reported by the above-mentioned paper is shown below.
[0113]
[Formula 1]



[0114] (M. A.Baldo, D.F.O'Brien, Y.You, A.Shoustikov, S.Sibley, M.E.Thompson, S.R.Forrest, Nature 395 (1998) p.151.) The molecular formula of EL ingredient (Pt complex) reported by the above-mentioned paper is shown below.
[0115]
[Formula 2]



[0116] It Lamansk(ies). M. -- A.Baldo and S. -- P. E.Burrrows and M.E.Thompson, S. -- R.Forrest, Appl.Phys.Lett., and 75 (1999) p.4. (it Watanabe(s) T. -- Tsutsui, M.-J.Yang, M.Yahiro, KNakamura, and T. --) T. (1999) The molecular formula of tsuji, Y.Fukuda, T.Wakimoto, S.Mayaguchi, Jpn.Appl.Phys., and EL ingredient (Ir complex) reported by the paper of the 38 (12B) L1502. above is shown below.
[0117]
[Formula 3]



[0118] If phosphorescence luminescence from a triplet exciton can be used as mentioned above, implementation of one 3 to 4 times the high external luminescence quantum efficiency of this will be attained from the case where the firefly luminescence from a singlet exciton is used theoretically. In

addition, in the spontaneous light equipment shown in an example 1 - an example 5, it combines freely and the configuration of this example can be carried out.
[0119] [Example 10] Since the spontaneous light equipment formed by carrying out this invention is a spontaneous light type, it is excellent in the visibility in a bright location compared with a liquid crystal display, and moreover, its angle of visibility is large. Therefore, it can use as a display of various electric appliances. For example, it is good to use the spontaneous light equipment of this invention for appreciating TV broadcast etc. by the big screen as a display of the EL display (display which built spontaneous light equipment into the case) of 30 inches or more (typically 40 inches or more) of vertical angles.
[0120] In addition, all displays for information displays, such as a PC monitor, a display for TV broadcast reception, and a display for an advertising display, are included in an EL display. Moreover, in addition to this, the spontaneous light equipment of this invention can be used as a display of various electric appliances.
[0121] As an electric appliance of such this invention, the picture reproducer (equipment equipped with the display which specifically reproduces record media, such as a digital videodisc (DVD), and can display the image) equipped with a video camera, a digital camera, a goggles mold display (head mount display), a navigation system, sound systems (a car audio, audio component stereo, etc.), a note type personal computer, a game device, Personal Digital Assistants (a mobile computer, a cellular phone, a handheld game machine, or digital book), and a record medium etc. is mentioned. Since importance is attached to the size of an angle of visibility, as for especially the Personal Digital Assistant with seeing [much] from across, it is desirable to use spontaneous light equipment.
[0122] Moreover, these electric appliances may carry a sensor called the photosensor which can control the brightness corresponding to surrounding brightness, in order to reduce power consumption. As for the contrast of the brightness of the spontaneous light equipment to surrounding brightness, at this time, it is desirable to make it set to 100-150. The example of these electric appliances is shown below at drawing 15 and drawing 16 .
[0123] Drawing 15 (A) is an EL display and contains a case 2001, susceptor 2002, and display 2003 grade. This invention can be used for a display 2003. Since it is a spontaneous light type, the back light of an EL display is unnecessary, and it can be made into a display thinner than a liquid crystal display.
[0124] Drawing 15 (B) is a video camera and contains a body 2101, a display 2102, the voice input section 2103, the actuation switch 2104, a dc-battery 2105, and television section 2106 grade. The spontaneous light equipment of this invention can be used for a display 2102.
[0125] Drawing 15 (C) is a part of EL display (right one side) of a head installation mold, and contains a body 2201, a signal cable 2202, the head fixed band 2203, Display a (2204), optical system 2205, Display b (2206), etc. This invention can be used for Display a (2204) or Display b (2206).
[0126] Drawing 15 (D) is the picture reproducer (specifically DVD regenerative apparatus) equipped with the record medium, and contains a body 2301, record media (DVD etc.) 2302, the actuation switch 2303, a display (a) 2304, and (Display b) 2305 grade. Although a display (a) mainly displays image information and a display (b) mainly displays text, the spontaneous light equipment of this invention can be used for these displays (a) and (b). In addition, a home video game machine machine etc. is contained in the picture reproducer equipped with the record medium.
[0127] Drawing 15 (E) is a pocket mold (mobile) computer, and contains a body 2401, the camera section 2402, the television section 2403, the actuation switch 2404, and display 2405 grade. The spontaneous light equipment of this invention can be used for a display 2405.
[0128] Drawing 15 (F) is a personal computer and contains a body 2501, a case 2502, a display 2503, and keyboard 2504 grade. The spontaneous light equipment of this invention can be used for a display 2503.
[0129] In addition, if the luminescence brightness of an organic electroluminescence ingredient will become high in the future, it will also become possible to carry out expansion projection of the light containing the outputted image information with a lens etc., and to use for the projector of a front mold or a rear mold.
[0130] Moreover, the above-mentioned electric appliance displays more often the information distributed through electronic communication lines, such as the Internet and CATV (cable television), and its opportunity to display especially animation information has been increasing. Since the speed of response of an organic electroluminescence ingredient is very high, spontaneous light equipment is desirable to a movie display, but if the profile between pixels fades, the whole animation will also fade. Therefore, it is very effective to use the spontaneous light equipment of this invention of making the profile between pixels clear, as a display of an electric appliance.
[0131] Moreover, in order that the part which is emitting light may consume power, as for spontaneous light

equipment, it is desirable to display information that the amount of light-emitting part decreases as much as possible. Therefore, when using spontaneous light equipment for the display which is mainly concerned with text like a Personal Digital Assistant especially a cellular phone, or a sound system, it is desirable to drive so that text may be formed by part for a light-emitting part by making a nonluminescent part into a background.

[0132] Drawing 16 (A) is a cellular phone and contains a body 2601, the voice output section 2602, the voice input section 2603, a display 2604, the actuation switch 2605, and an antenna 2606 here. The spontaneous light equipment of this invention can be used for a display 2604. In addition, a display 2604 can stop the power consumption of a cellular phone by displaying a white alphabetic character on a black background.

[0133] Moreover, drawing 16 (B) is an audio for mount, and includes a body 2701, a display 2702, and the actuation switches 2703 and 2704 in a sound system and a concrete target. The spontaneous light equipment of this invention can be used for a display 2702. Moreover, although this example shows the audio for mount, you may use for a pocket mold or a sound system for home use. In addition, a display 2704 can stop power consumption by displaying a white alphabetic character on a black background. Especially this is effective in the sound system of a pocket mold.

[0134] As mentioned above, the applicability of this invention is very wide, and using for the electric appliance of all fields is possible. Moreover, the electric appliance of this example may use the spontaneous light equipment of which configuration shown in examples 1-8.

[0135]

[Effect of the Invention] This invention can be carried out and the ejection effectiveness of the light in a light emitting device, especially an EL element can be improved by establishing a light-scattering object on an insulator. Furthermore, micro processing of a pitch becomes possible by etching the transparent film and forming a light-scattering object. It becomes possible by making a light-scattering object with a fine pitch form as mentioned above to offer spontaneous light equipment with high luminous efficiency.

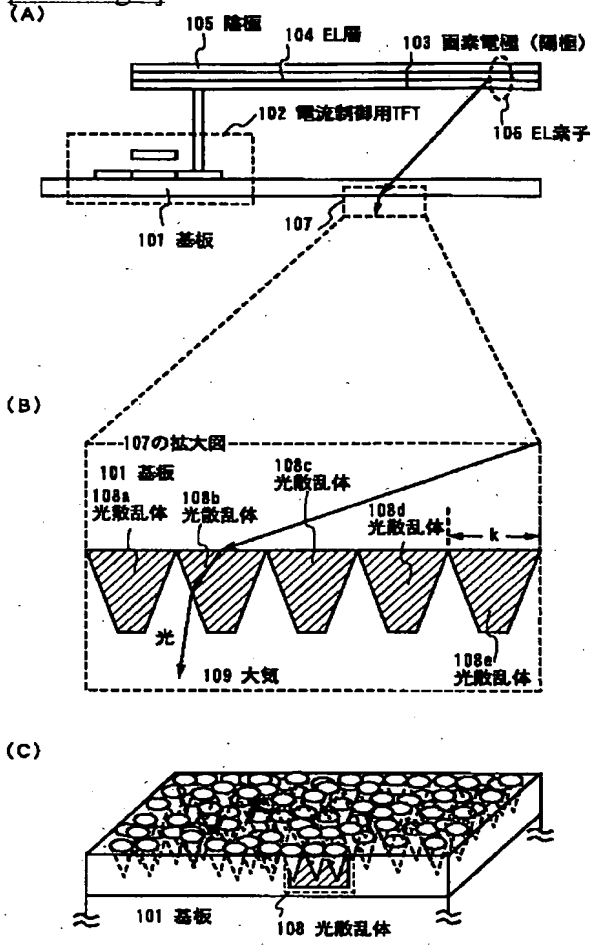
[Translation done.]

* NOTICES *

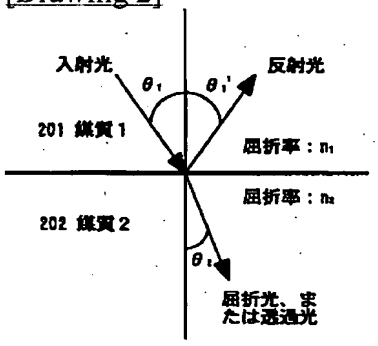
1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DRAWINGS

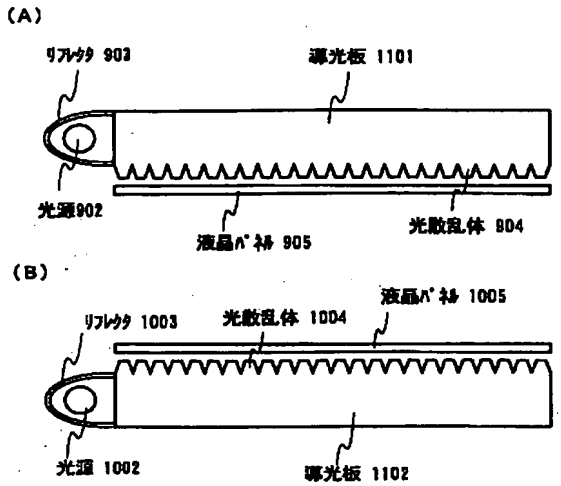
[Drawing 1]



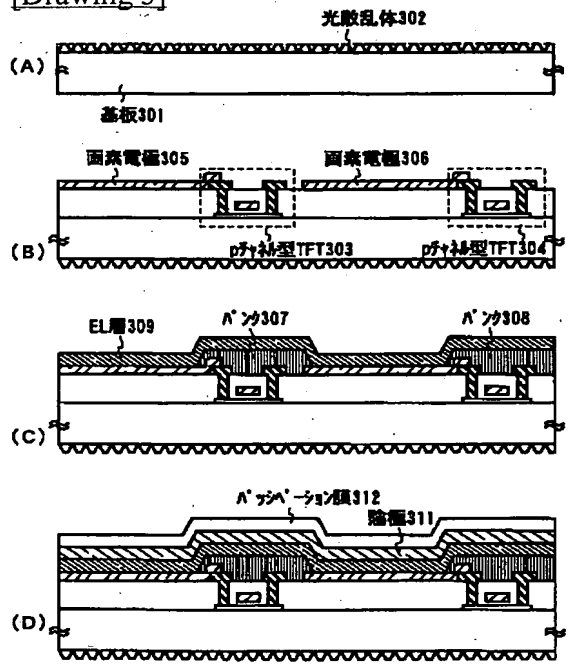
[Drawing 2]



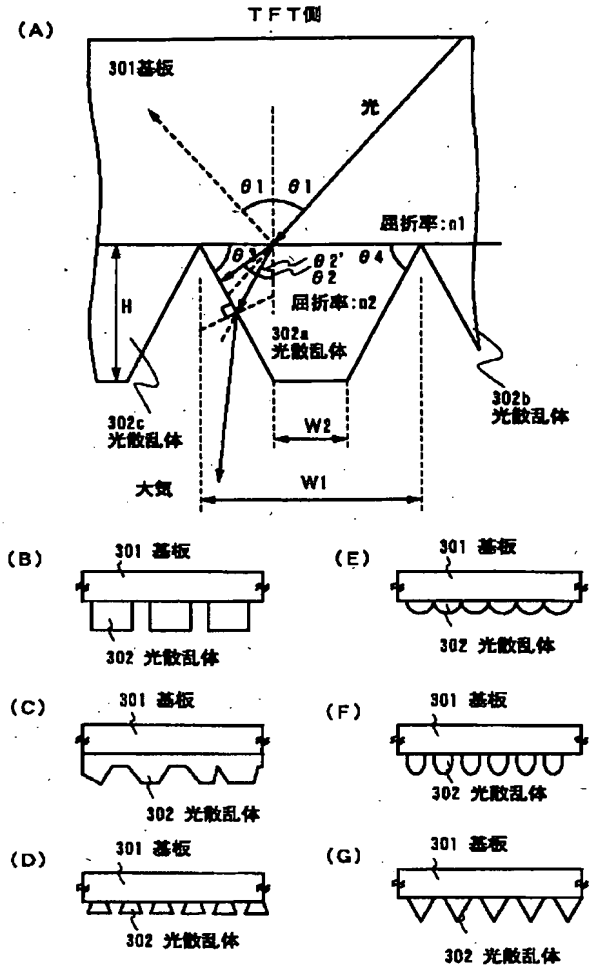
[Drawing 11]



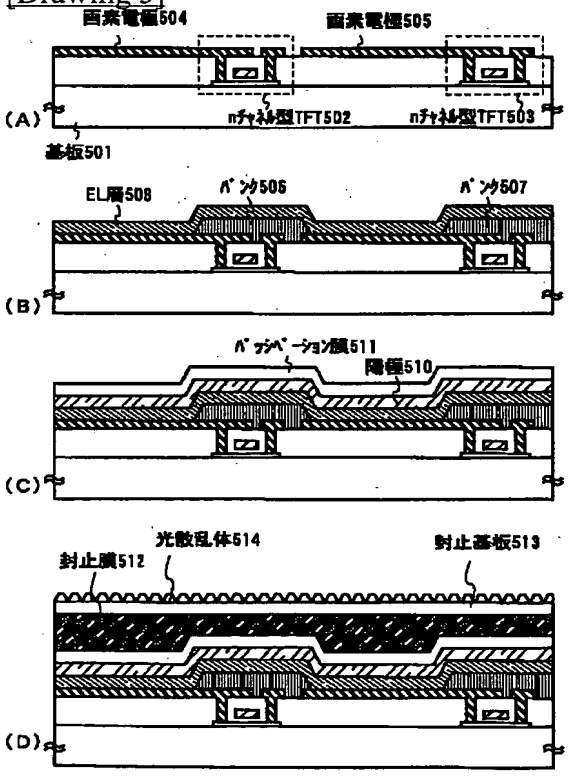
[Drawing 3]



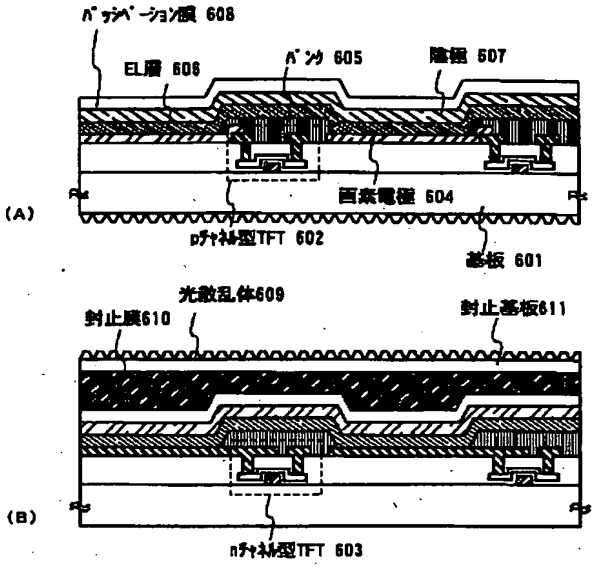
[Drawing 4]



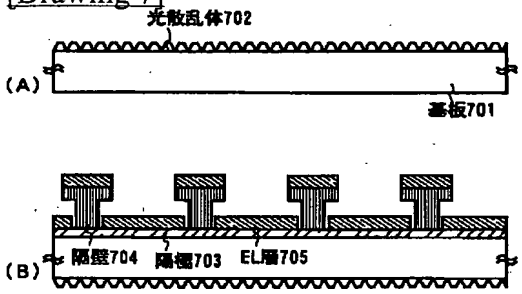
[Drawing 5]



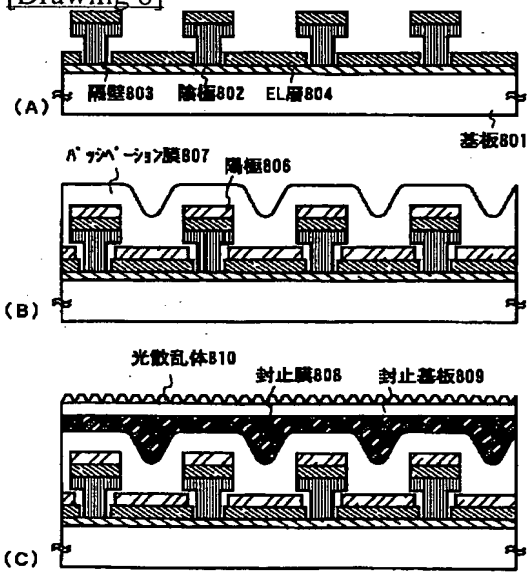
[Drawing 6]



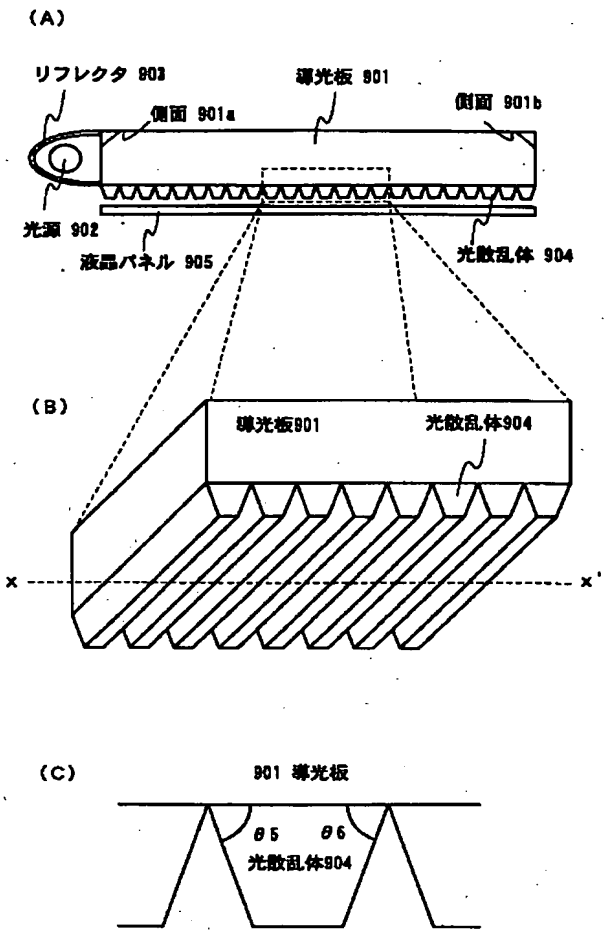
[Drawing 7]



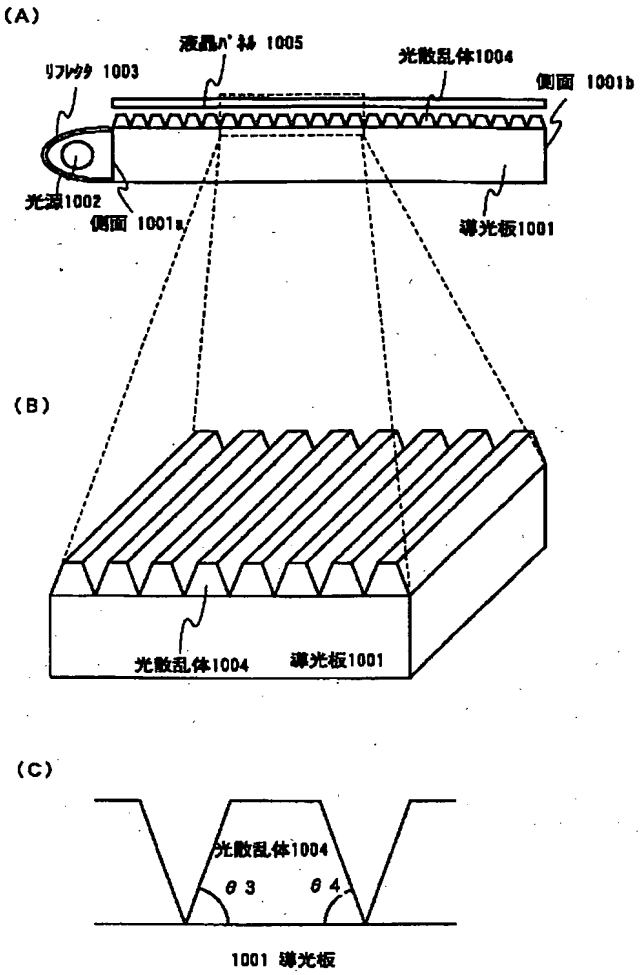
[Drawing 8]



[Drawing 9]

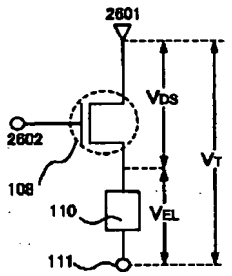

(A)
リフレクタ 903
導光板 901
側面 901a
側面 901b
光源 902
液晶パネル 905
光散乱体 904
(B)
導光板901
光散乱体904
x
x'
(C)
901 導光板
θ5
θ6
光散乱体904

[Drawing 10]

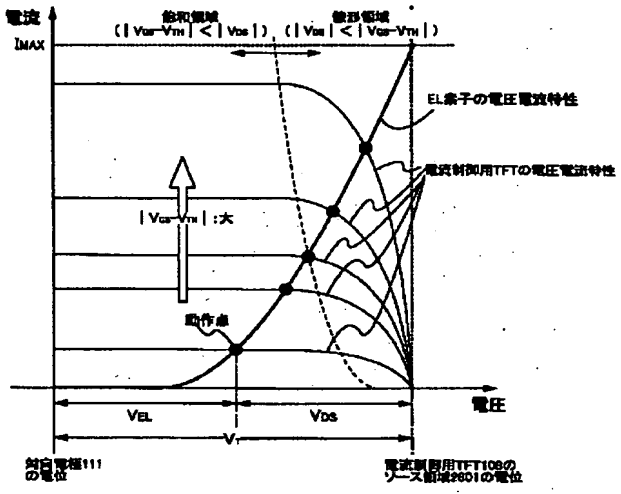

(A)
液晶ﾊﾟﾈﾙ 1005
光散乱体1004
ﾘﾌﾚｸﾀ 1003
側面 1001b
光源1002
側面 1001a
導光板1001
(B)
光散乱体1004
導光板1001
(C)
光散乱体1004
θ3
θ4
1001 導光板

[Drawing 12]

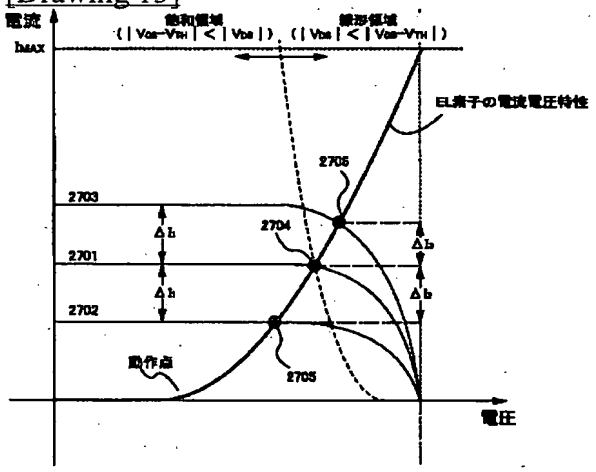
(A)



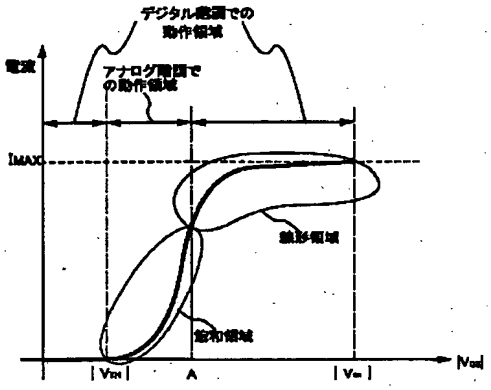
(B)



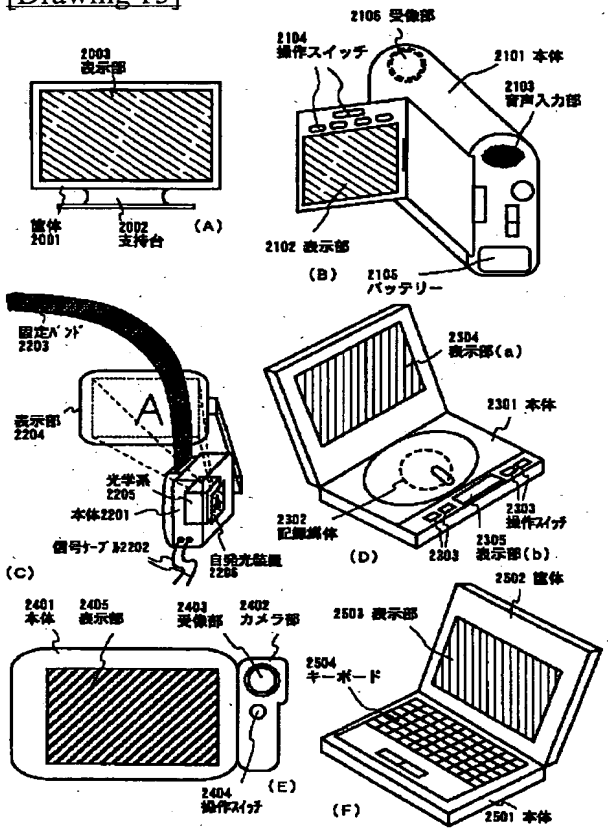
[Drawing 13]



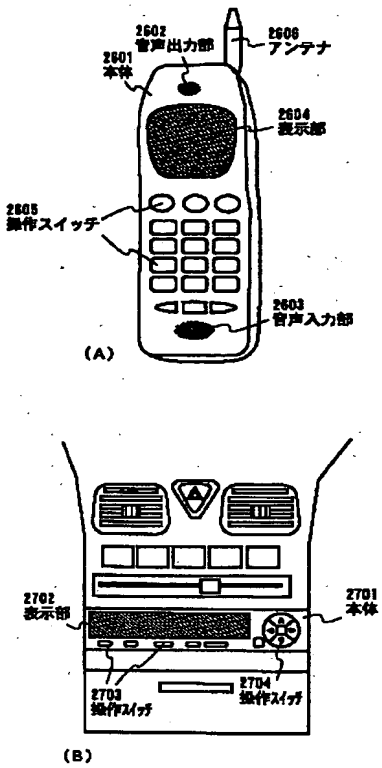
[Drawing 14]



[Drawing 15]



[Drawing 16]



[Translation done.]